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CONTENTS.

THE TOCKLAI CLEARANCE.

At the Tocklai Experimental Station a small clearance consisting of 8 half-acre plots of different varieties of tea has been established.

A short account of the treatment given and of the present condition of the tea may prove interesting.

The object of the clearance is merely to show fair specimens of tea of the varieties chosen. No exact account of cost for labour, etc., has been kept, but at the same time care has been taken that the tea at no time has received such treatment as would be impossible, or financially impracticable, on a garden; though with such a small clearance situated near our laboratory it has naturally received more supervision and observation than is possible on a big estate.

The land is old grazing land, chemically very poor. Mechanically it would be described as a fine sandy silt. There is little of that coarse sand which is of such material value in getting a soil into good tilth, and on the other hand there is very little clay. Such soil never becomes extremely hard to hoe, but it possesses the unpleasant property of setting very hard after rain, with a smooth surface impervious to water and air.

It was clear, when this soil was first put under cultivation, (early in 1913) that it needed the addition of large quantities of organic matter if tea was to be made a success on it. After levelling, the land was given 10 maunds of lime, followed by a liberal dressing of cattle manure, and Boga medeloa was sown. A very good crop was obtained, better than was expected on this soil. This was hoed in.

In the following cold weather (December 1914) the first six half-acres were planted with one-year old plants of Manipuri, Burmah, Kalline, China, Kharikatea, and Singlo varieties respectively. Planting was $5' \times 5'$ square.

Excellent nurseries of the first five were obtained, providing an abundance of seedlings so that it was possible to reject those plants obviously deformed, or stunted.

In all nurseries, some plants appear which have not the characteristic appearance of the particular jat to which they belong. Such plants also were rejected.

In the case of the Singlo variety, possibly mainly on account of a poor sample of seed, but also probably because seed grown on the Singlo soil did not find itself in a favourable environment on the poorer soil here, the nursery did badly and every plant had to be used. In consequence the Singlo clearance is not in a condition for fair comparison with the others.

In March 1915, Boga medeloa was planted in hedges between alternate lines of tea. This Boga medeloa was cut at intervals and the prunings were buried by the succeeding light hoe. Six light hoes were given, and in addition the bushes were occasionally forked round.

The clearance is situated on a strip of land 260 feet wide. running roughly North to South bordered on one side by the Government road (on a bund 5 feet high), between which and the clearance are borrow pits. On the other side is the main drain of the station, about eight feet deep.

It was thought that such drainage would be sufficient on such light soil, but it was found that the bushes for about six lines bordering the Government road did not grow at all well, though they remained alive. Drains three feet deep were put in at intervals of 35 feet, but water soaking in from the borrow pits was not removed quickly enough, and when bushes near the road were pulled up they were found to have very poor roots.

It was necessary therefore to make a catch drain between the borrow pits and the clearance, and this was done, the catch drain being kept dry by a deep drain along the south side of the clearance.

Those bushes which were previously affected by the inefficiency of the drainage are now growing vigorously.

In October 1915 the Boga medeloa was trenched in between alternate lines of tea 15 maunds of slaked lime were put in with a fairly deep (20 nulls) hoe in January. In March 1916 200 lbs. of sterilized animal meal, and 100 lbs. of superphosphate were broadcasted and turned in with fork hoes. As it was decided to limit expenditure on manuring to such as might be considered an average treatment possible on a garden, a mixture richer in nitrogen could not be afforded. Analysis of the soil and experiments on similar soil at Borbhetta had shown that phosphates were a necessity on this soil; on most soils money would be better spent on a manure more largely nitrogenous.

No doubt it would have paid to put in another green crop this year, but it was decided not to do so, since a good crop of Boga medeloa had been grown and trenched in the year before.

The bushes have now (October) been cut down to 2 inches; such plants as have not reached a minimum thickness of one inch having been left till the following spring. Plucking will be commenced at 27 inches, so that plants which are cut down late will be spared while the others are being plucked and so tend to level up.

A few notes on each variety are here appended for record.

There are at present very few vacancies. Vacancies were infilled in October 1915, and again in March 1916. No exact account was kept of infillings, but the number was extremely small, except in the case of China bushes, where it was about 5 per cent.

Diameter of stems at 2 inches from ground above.

	2″ and above.	1½″ to 2″	1″—1½″	½″ 1	½″ and below.	Vacancies.
Manipuri ...	2	17	58	20	3	*nil.*
Burmah ...	2	15	64	17	2	*nil.*
Kalline ...	5	20	63	10	2	*nil.*
China ...	1½	18	72	7	1	½
Kharikatea ...	3	23	60	10	3	1

Appearance of bushes.

MANIPURI.—While the majority of the bushes have very dark leaves of the long pointed type usually associated with this variety, about 10 per cent. show a light, very broad, and shorter leaf; these bushes are generally less well grown. Bushes which have been allowed to run for 2 years usually show a smaller type of leaf than pruned bushes, but about 2½ per cent. of the bushes of this plot now resemble a good hybrid rather than the usual Manipuri type. No bush developed seeds, but about 1 per cent. showed very young flower buds.

This plot is rather uneven in appearance, the height varying from 3 to 8 feet, but all are very bushy, and look healthy.

BURMAH.—The leaf generally very closely resembles that of the Manipuri variety. There is perhaps a larger number of bushes showing somewhat shorter and broader leaves which are still very dark in colour. No bushes with the broad pale leaf are seen in this plot. There are only a few bushes (less than 1 per cent.) of the hybrid type. No bushes have developed seed, but 1 per cent. show very young flower buds. This plot is the most even of the whole series. The average height is about 5 feet. and few bushes are much lower or much higher than this. Practically every plant is a broad bush, and all look extremely vigorous and healthy.

KALLINE.—In this plot there are the largest bushes of any of the series, but there are also some rather small bushes. In general appearance this plot looks remarkably dark and healthy, but there is a larger number of bushes of hybrid appearance than in either of the other dark-leafed indigenous varieties. About 1 per cent. of the bushes are seeding, whereas none of the Manipuri or Burmah bushes show seed; and a larger number are now in flower.

CHINA (BORAJALINGA.)—These plants at present have a much better appearance than the average old China bush seen on

an old garden. Many of the bushes would be described as fair or good hybrid.

The figures in the table showing diameter of stem are not of so much value as in the case of the other varieties because a thick stem often bears a poor seed-laden bush, while a thin stem often branches out into a vigorous plant, which will make a good flushing bush quickly. The tendency to "break" from the bottom is very marked as is usual with China and hybrid bushes.

The feature of this clearance is the number of bushes which bore seed, some being so heavily laden that all the branches were broken, while only about 30 per cent. developed no seed. While the other varieties are now quite free from pests and blights, there are still China bushes affected by Red Spider and Red Rust, and this plot has all along been particularly liable to these diseases.

KHARIKATEA.—This is a Singlo once removed, and its acclimatization seems to have freed this variety from the tendency to weakness shown by the sample of Singlo seed used here.

This plot did not make such an early start as those of the dark-leaved varieties, but is now as well grown as any here, though there are still a few plants which do not appear to have become established. The plants generally have not made such extremely bushy growth as the other varieties. It is a light-leafed variety and therefore does not show to the eye the very dark healthy appearance of the dark leaved varieties, but is nevertheless growing vigorously and will do well.

This plot stands on rather higher ground and was not affected greatly by the original inefficiency of the drainage. For this reason the average diameter of the plants compares well with that of any of the other plots.

SINGLO.—Such plants as have become established are doing fairly well, but as about 25 per cent. of vacancies have

had to be infilled this plot is not in a fair state for comparison with the others. The infillings are all growing quickly and it is probable that after some years this plot will compare quite well with the others.

There are also two further half-acre plots planted in July 1915, at seven months old, that is a year younger than the plots already described.

BETJAN.—These plants have made remarkably good growth and if they fulfil their early promise will in a few years be ahead of any of the other plots on the station.

The leaf is very large, broad, and soft, and of splendid appearance. It appears to be very liable to leaf diseases, but these diseases make no difference to the growth of the bush, which continues to be extremely vigorous.

PANIGHAT.—These plants too are generally quite well grown but not so remarkably as the Betjan.

The leaf is narrow and pointed, and not remarkably large, but is not affected by leaf diseases to any great extent.

THE EFFECT AT BORBHETTA OF PHOSPHATIC MANURES ON A GREEN CROP WHEN APPLIED WITHOUT OTHER MANURE.

Previous work (Quarterly Journal 1915, part IV ; and 1916 Part III) has shown the comparative effects on the growth of green crops of the addition of a phosphatic manure in various forms to a complete manurial mixture containing lime.

The effect of phosphatic manure under these conditions was found to be so great that it was considered desirable to try the effect of phosphates used alone and in quite small quantities.

The form of bones used in the first experiments was Degelatinised Bones which were delivered and applied in big lumps over half an inch long. It was thought probable that the comparatively low availability of the bones was due to their state of division, and this point needed proof. It was also desirable to see what would be the effect of using a strongly acid manure like superphosphate on an acid soil in the absence of lime.

The results obtained cannot be accepted with the absolute confidence that may be placed in those recorded in regard to the experiments already quoted, where each experiment was repeated in 12 different series of plots ; nevertheless the land used for this new series was very carefully selected, no levelling has been necessary, and to all appearance it is extremely even.

The results shew differences of sufficient magnitude to be accepted at least as far as the order of efficiency of the various manures is concerned.

Five plots received 40 lbs. each of phosphoric acid in the forms of basic slag, superphosphate, steamed bone-meal, unsteamed bone-meal, and bone-dust ; while the sixth plot was left unmanured. No lime or any other manure than those above mentioned was applied to any plot. The land was old grazing land to which no manure had ever been applied.

The crops were carefully pulled up and weighed at exactly six weeks old.

Manure.	Content of phosphoric acid per cent.	Price per ton in Calcutta.	Rate of application in lbs. per acre.	Cost of manuring per acre.		Wt. of crop per acre cwt.	Increase per cent.	Cost of 1 ton increase in annas.
		Rs.		Rs.	A.			
Nil.	...	...	...	...		28·2	...	...
Basic slag ...	11	90	364	14	10	66·0	135	124
Superphosphate ...	21	90	194	7	13	57·2	103	86
Steamed bone meal 3/16 mesh ...	22	70	190	6	10	52·2	85	81
Unsteamed bone meal 3/32 mesh	22	65	190	5	8	58·8	105	57
Bone dust ...	20	60	200	5	6	61·4	114	52

It will be seen from the above table that, per unit of phosphoric acid applied, basic slag gives markedly superior results; superphosphate, unsteamed bone-meal, and bone-dust are roughly equal and give the next best result, while that of steamed bone-meal is considerably less.

It is noticeable that these particular bone products give results in the inverse order of their price. This is undoubtedly due to the relative fineness of grinding—the steamed bone-meal being the coarsest of the three, while though the bone dust contained some rather large particles, the bulk of it was very fine indeed. The efficiency of bones would appear to depend upon the number of particles per unit weight.

It will be remembered that on this soil we have shown that the effects of basic slag and superphosphate were equal for the same weight of phosphoric acid, if applied following even a very light dressing of lime. It is now clear that this is not so when no lime is applied.

The superphosphate plot was slightly yellowish in appearance and had not the fine healthy look of the basic slag plot. In fact it was clear that it would not be safe to continue with this strongly acid manure on this acid soil, unless some lime were applied.

The bone products are free from this objection of acidity and are even cheaper to apply than superphosphate. It is clear therefore that the most economical phosphatic manure at present prices will be either unsteamed bone-meal or bone-dust. It is as yet not certain that these manures would be relatively so efficient on heavy soils, but on all light soils they may be applied with the greatest confidence.

One ton of cowpea plants contains rather more nitrogen than 2 maunds of oilcake, so that in the cases of unsteamed bone-meal, and bone-dust the cost of the application of the phosphatic manure is repaid at once by the value of the additional nitrogen added to the soil by the excess green crop. In addition the soil still has the benefit of the phosphate added, and of the larger quantity of organic matter.

Further advantages of this combination of green crops with phosphatic manure were explained in the article on "The Application of the Green manures" in Quarterly Journal, part II, 1915."

In these experiments unsteamed bones have done better than steamed bones. This is undoubtedly due to the greater fineness of the unsteamed bones used. Other things being equal, steamed bones should be rather more readily available than unsteamed bones, and as steamed bones are more easily ground it is difficult to understand why steamed bones are obtainable in Calcutta only in a coarser grade.

Bones are capable of carrying diseases, particularly anthrax, and it is worth while to pay the extra Rs. 5 charged for steaming so that the chance of carrying diseases may be avoided.

It is to be hoped that more finely ground steamed bones will be placed on the market.

A MODIFIED METHOD OF GREEN MANURING.

In the quarterly journal No. 2, 1916, an account was given of certain interesting laboratory experiments by C. M. Hutchinson, published in Bulletin No. 48 Ag. Res. Inst., Pusa.

By these researches Hutchinson was led to the conclusion that a great improvement in efficiency might be obtained if green crops instead of being buried in the area upon which they grew, were first treated in such a way as to bring them into a more suitable condition for use as manure.

In Bulletin No. 63, there is now published an account of field results which confirm the theoretical conclusions arrived at.

The bulletin is of importance and its perusal would be of great interest and benefit to all planters who are interested in understanding the principles which govern the methods they practice for the improvement of their gardens.

> "*The method.*—Borrow pits were dug at the sides of the field previous to cutting the green crop: this being done during the rains the pits filled with water; the cut crop was placed in the pits, left there for periods varied experimentally from 24 to 48 hours, removed from the pits, stacked in heaps and allowed to ferment for varying periods of time, after which the rotted manure was applied to the soil. It was at first found necessary to water the heaps occasionally to prevent drying out, but this was subsequently avoided by plastering their outsides with clay, comparatively small quantities of water being occasionally applied to prevent cracking of the latter.
>
> Further modifications of this method were adopted subsequently; in order to avoid loss of nitrogen as ammonia, the water remaining in the pits was used for moistening the heaps, and the soil at the bottom of the pits was

dug out and made into alternate layers with the green manure in the heaps. As large quantities of ammonia pass into the water during fermentation the smallest possible quantity of water should be used so as to make it possible to utilize the whole of it for moistening the heaps.

It was found that more complete fermentation could be obtained by inoculating the heaps with impure cultures of cellulose-destroying bacteria obtained simply by making a water extract of fresh cowdung.

It will be seen from the above description of the method that its main object is to obtain more complete decomposition of the organic matter than can be arrived at by the ordinary process of burying, this result being achieved by introducing anaerobic conditions in the early stages. Variations of the method should be made to suit local conditions, merely keeping the general principle in view in so doing.

It appears to the writer that certain advantages are connected with the use of this method as compared with the ordinary practice, and that they may in many case more than balance the extra cost of the labour required for carrying it out."

Advantages.—It was shown in the first publication that the efficiency of green manuring as usually practised is absolutely dependent upon a sufficient supply of water for the decomposition of the buried green manure, so that the ordinary method failed in the absence of convenient showers of rain, while this new method proposed is independent of rainfall.

Other advantages are the immediate return from green manure treated in this manner compared with that buried in the ordinary way; and that when it is found that the quantity of manure grown on a given area is insufficient to produce the best effect the total green manure may in such a case be concentrated upon a smaller area.

Also the fermentation in the soil of old plants has been shown to be not so satisfactory as that of young succulent plants.

This new method allows older and therefore more bulky crops to be made use of.

> "The immediate action of fermented sunn hemp was shown in experimental plots $\frac{1}{24}$th of an acre sown with oats. Here the fermented manure was concentrated by application to half the area on which it was grown."

The resulting figures were :—

Treatment.	Grain.	Straw.	
Control	885	2,820	lb. per acre.
Sunn hemp ...	960	2,835	
Fermented sunn hemp ...	1,540	2,970	

> "This experiment was repeated in the following season both with oats and tobacco, but in this case the results were modified by the fact that the amount of soil moisture present varied from an optimum amount in the plots forming one row at the north end of the field down to a quantity obviously insufficient for full growth at the south end. The plots were arranged in triplicate in three rows running east and west, so that, in the north row the moisture was good, in the middle row it was slightly in defect, and in the south row decidedly so. The results varied in accordance with this difference. In the north row there was but little difference in crop between the plots which had had sunn hemp buried and sunn hemp fermented, the moisture present being sufficient to ensure decomposition of the green manure, whereas in the south row the fermented manure produced a considerably higher return than the buried green crop."

This experiment on the north rows containing an optimum amount of soil-moisture is extremely important from the point of view of the tea industry.

It is shown that *where water conditions are favourable* there is no advantage to be obtained by using this preliminary fermentation rather than in hoeing in the green manure where it grew.

Now in the tea districts it should nearly always be possible to grow the green manure at such a season that sufficient rainfall can be depended upon both to obtain good growth of the green manure, and to ensure its proper decomposition after burial. It is also to be noted that the benefit of the fermented green manure in the first experiment was mainly shown in increased production of grain, there being no great increase in vegetative growth. In tea cultivation it is our object to increase vegetative growth.

"In a further experiment on manuring tobacco with fermented sunn hemp, two methods of preparing the material were tried.

(1) Aerobic, in which the green manure was fermented in heaps kept moist but not covered with clay.

(2) Anaerobic, in which the heaps were plastered with clay. The sunn hemp was first cut into short lengths and soaked in water in a pit for 24 hours. It was then removed from the pit and transferred to another shallow one, in this case about one foot deep and eight feet square.

Aerobic fermentation.—In this method the soaked material was arranged in alternate layers of sunn and soil, the former about 3 inches and the latter about ½ inch in thickness. The whole heap was than covered with a layer of soil about 3 inches thick and finally with one of straw to prevent evaporation. Watering was carried out about once a week, sufficient water being added to keep the top layer moist.

Anaerobic fermentation.—The heaps were arranged in the same way, but each layer was consolidated by treading down and the whole heap was finally plastered with clay about one inch thick.

Fermentation was carried on from 15th August to 5th October 1915 (about 48 days), after which the heaps were opened up and the fermented material transferred direct to the soil of the experimental plots.

Application. The preparation of the fermented manure was not carried out in time to allow of its application to the soil sufficiently early to entirely avoid toxic effects. Two methods of application were adopted in order further to test the existence of toxins in the anaerobically prepared material.

(*a*) In these plots the manure was buried in furrows, the plants being placed in intervening ridges.

(*b*) In these the manure was buried in the ridges the plants being in the furrows.

The fermented manure was applied at rates which represented concentrations of 3 : 1 in one series and 6 : 1 in the other, *i.e.*, the amount used on one acre was prepared from the green manure crop cut from three acres in the first and from six acres in the second.

The results are given in the following table":—

"TOBACCO MANURING WITH FERMENTED SUNN HEMP.

No. of plots.	Treatment.	Green Leaf. Furrow (*b*.)		Pounds per acre. Ridge (*a*).	
		lb.	Increase lb.	lb.	Increase lb.
1	No manure	11,252	......	9,609	......
	Fermented Sunn anaerobic 3 : 1	12,022	770	11,500	1,891
	Fermented Sunn aerobic 3 · 1	14,550	3,298	13,548	3,939
	Fermented Sunn anaerobic 6 : 1	14,898	3,646	16,118	6,509

" In these plots the superiority of the aerobically fermented manure over that prepared anaerobically is obvious; there is reason to believe, however, from other observations, that this would not invariably be the case,

especially in view of the fact that the manure was not allowed any opportunity of aeration after fermentation and before burying in the soil. The plants in the ridges gained an advantage in this respect from the fact that their feeding roots did not reach the manure so early as did those of the furrow planted seedlings, as well as from the better aerated soil in the ridges in which they made their early growth. before drying out of the soil had taken place to any extent. When this began to occur the roots had reached the buried manure and were not only benefitting by the nitrogen supply derived there from but from the moisture-holding power of the well rotted vegetable matter, to which reference has already been made.

"With regard to the difference in character of the anaerobic and aerobic preparations, it was found that when first taken from the heap the former contained no nitrate but a considerable amount of ammonia (recoverable by distillation with magnesia although not free). A water extract of the material was toxic to seedlings, but this condition was changed and nitrate formation took place after aerobic conditions were introduced, more complete nitrification of the organic nitrogen present being eventually obtained than was the case with the aerobically prepared material. This was in accordance with the laboratory observations of the previous year, and confirms the conclusion as to the possibility of preparing a more rapid acting manure by this method, keeping in view, however, the necessity for interposing an aerobic stage between the anaerobic preliminary one and the final application to the soil, not only to promote nitrification, but to ensure the oxidation and destruction of the toxins produced".

This work done on this method of using green manure is of great interest to the Tea Industry because it affords valuable information on the manner of action of green manures. On the present evidence, however, we are of opinion that in the plains the

new method is not likely to prove of practical value in tea cultivation; chiefly because the moisture conditions for green manuring as at present practised in the tea districts are generally so satisfactory that the advantages to be gained by this new method are not likely to be sufficient to repay its increased cost.

On steep slopes such as are found in the Darjeeling district the correct treatment of a green crop has always been a difficulty.

The hoeing in of a green crop would there lead to such an increase in loss of soil by wash that the general method of treatment cannot be followed.

The more general practice has been to allow the crop to rot on the surface where it grew with or without previous sickling: which method entails a considerable loss in efficiency.

Some modification of one of the methods described by Hutchison may be expected to give sufficient advantage to repay its increased cost.

From what has been quoted it will be seen that this research is not yet completed, in that the best method of effecting the preliminary decomposition is not yet ascertained with certainty.

In Darjeeling too we have the advantage that the rainfall would generally be sufficient to render watering by hand unnecessary. Having regard to the necessity of making the smallest possible demand on labour, the following method is suggested for the present:—

Cut the green manure and rake into convenient heaps. The green stuff in the heaps should be trodden down as compactly as possible, watered, extract of cowdung added, and then covered with about 3 inches of soil. The heaps should be allowed to ferment for about 48 days, with occasional watering if necessary.

The fermented material should then be spread over the soil and allowed to lie exposed to the air for about a fortnight and then forked in.

If a little bone dust were mixed with the heap it would increase the efficiency of the green manure and it would probably decrease the length of time necessary for fermentation.

STERILISED ANIMAL MEAL.

This manure has been used largely on tea estates in North East India during the last eight or ten years, and various reports of its action have been made from time to time in this Department's publications.

At the present time the name Sterilised Animal Meal is used by more than one Calcutta firm which deals in manures, and this name carries with it no guarantee that any definite class of raw products has been used in, or that any particular treatment constitutes, its manufacture, nor is there any criterion as to the composition of the finished article other than that given by the percentages of total nitrogen and phosphoric acid contained in it.

The manure of this name, however, referred to in the publications of the Scientific Department, was, until the outbreak of the war, sold by one firm only, and in its manufacture the following features were invariably maintained :—

(1) The materials of which it has been made have consisted entirely of animal products :

(2) Each of these have been treated at least to a temperature of 212°F.

(3) The material has been largely derived from whole carcases so that in addition to bones, blood, and horn, it contains material derived from meat :

(4) In the process of preparation meat and bones are extracted by means of steam under pressure, which removes oil and glue.

The following details of the manufacture of this Sterilised Animal Meal will be of interest to those planters who have made use of it on their estates, for the bulk of the Sterilised Animal Meal sold at present in Calcutta is manufactured in exactly the same way and constitutes the same product.

In Calcutta the carcases of horses, cows, and buffaloes, etc., are at the disposal of the municipality, which has been in the habit of letting this monopoly to firms who manufacture Sterilised Animal Meal. It is an interesting fact that in Calcutta the dead animal is not the property of the individual who owned it when alive, in fact the removal of the carcase to such place or places as the municipality directs must be done at the expense of the owner of the animal when it was alive. In the process of transport carcases are often purchased for small sums by members of leather working castes from the people who are removing them. The carcases in such cases are thrown away, after removal of the hide, and devoured by vultures, and are lost for purposes of manure manufacture.

In the preparation of Sterilised Animal Meal by the two firms which on one or other occasion have shown the writer over their works, the carcases were skinned and cut into large pieces and put into an inner perforated cast-iron cylinder which was surrounded by an outer air-tight steam-jacketted cylinder about five feet in diameter. The perforations in the inner cylinder are about half an inch in diameter. The treatment consists in drying in superheated steam for five hours. During this time (beginning from $\frac{1}{4}$ hour after turning on the steam) a liquid resembling soup is run off through the outlet into a vertical vessel the "Separator" in which it collects, and oil or tallow comes to the surface. The outlet of the "Extractor" is then closed again and the inner perforated horizontal cylinder is then revolved while superheated steam is driven into the outer jacket (not into the chamber itself) and the top of the extractor opened to the air. At the end of three hours drying the meat falls away from the bones and is in a sufficiently finely divided condition to fall entirely through the holes in the inner horizontal cylinder on to the bottom of the chamber, in the form of a fine mealy powder mixed with coarser pieces of fibre and small bones.

The liquid which is run off through the outlet into the separator is allowed to stand until oil collects on the surface. This oil is suitable for the manufacture of country soap. The liquid which is run off after separation of the oil contains gluey substances which are rich in nitrogen, but the evaporation is a costly matter.

The finely divided dry meat material and the bones, which are obtained by this extraction, form the basis of Sterilised Animal Meal and are mixed with the materials obtained by the extraction of raw products other than whole carcases, *i.e.*, fresh bones, dry bones, horns, and hoofs. The percentages of nitrogen and phosphoric acid contained in these products varies to some extent, but are roughly as follows :—

		Nitrogen.	Phosphoric acid.
Meat meal ...	(Derived from carcases) ...	7·5	7·5
Horn ,, ...	(Derived from horns and hoofs) ...	10·0	2·0
Extracted bone meal Steamed bone dust	(Derived from raw and fresh bones)	5·5	20·0

The resultant mixture of these substances in the proportions in which they are produced would contain a considerably greater proportion of phosphoric acid than would be suitable for a manure which is to be well balanced for tea, because larger quantities of bones, which are richer in phosphoric acid than in nitrogen, are obtainable than of horns, hoofs, and meat, which are richer in nitrogen, and consequently materials of high nitrogen content which still are capable of coming under a category indicated by the name Sterilised Animal Meal are required to balance the manure. For this reason blood meal which contains anything from 9 to 13 per cent. of nitrogen is an extremely valuable auxilliary. Blood is obtained from slaughter-houses and blood meal is prepared simply by the evaporation of the water it contains. The early stages of this evaporation are carried out by boiling, small quantities of sulphuric acid being added to the boiling blood to prevent loss of ammonia which would otherwise take place during the process of evaporation. Blood meal is a black shiny granular substance, easy to handle, and with good keeping properties, and it is reported to be quick in action, and consequently it is a valuable means of increasing the ratio of nitrogen to phosporic acid in Sterilised Animal Meal and increasing at the same time its rapidity of action as a manure.

In a manure prepared in this way from several ingredients it is inevitable that there should be slight fluctuations in the nitrogen and phosphoric acid content, and it is usual to adjust these if necessary by the addition on the one hand of more bones to increase the phosphoric acid content or on the other of small quantities of soluble substances of high nitrogen content such as sulphate of ammonia or nitrate of soda.

It is desirable that the quantity of soluble nitrogenous manures incorporated in this way with Sterilised Animal Meal should be confined to a quantity sufficient to alter the nitrogen content of the whole by a few units per cent. only. Otherwise the nature and action of the manure might differ from that indicated by its name.

The percentage composition having been adjusted it is necessary that the manure should be properly bulked and sufficiently finely divided to allow of easy distribution and quick decomposition. Bones and meat meal products should be sieved through a 3/32" mesh. The blood meal and other ingredients on account of their more ready decomposition do not require to be so finely divided. Horns and hoofs too do not lend themselves easily to such fine division, but the criticism can be levelled at many samples of Sterilised Animal Meal taken at random in the tea districts that the fragments of bones are not sufficiently small.

When carefully prepared, and if protected as far as possible from rain or excessive moisture, Sterilised Animal Meal keeps well.

Ordinarily Sterilised Animal Meal contains about half a per cent. of potash, and several special Sterilised Animal Meals are on the market which consist of ordinary Sterilised Animal Meal prepared as described above, mixed with different percentages of nitrate or sulphate of potash with the object of increasing the amount of potash to a figure which permits of the sellers referring to it as being a "complete" manure, *i.e.*, one which contains nitrogen, phosphoric acid, and potash in well balanced relative proportions.

The special merits of Sterilised Animal Meal are due to the fact that is a concentrated organic manure containing high percentages of nitrogen and phosphoric acid, in various degrees of avail-

ability. It is recognised that bones alone, even although they contain a small percentage of nitrogen, have often proved ineffective as a manure for tea, but that, when used in intimate combination with readily available nitrogenous organic substances, their value is very much increased. It is probably for this reason chiefly, that, taken over a range of soils and seasons, Sterilised Animal Meal has acquired a well merited popularity. The best results are usually obtained when it is used on light well drained soils, but it also does well on certain heavier soils particularly those of the Red Banks.

A type of manure closely allied to Sterilised Animal Meal is fish. In this, however, most of the nitrogen is in a rather more readily available form, and fish manures, for this reason, act more quickly, but it is probable that for the same reason the nitrogen in these manures is rendered available and made use of before much of the phosphoric acid has come into action, and consequently the residual effect of fish manures is usually less noticeable than that of Sterilised Animal Meal.

G. D. H.

ADDRESS TO DARJEELING PLANTERS.

Extract from the minutes of the proceedings of an Extraordinary General Meeting of the Darjeeling Planters' Association, held at the Club Premises, Darjeeling, on Saturday, the 29th July 1916, at 12 o'clock, the President, The Hon'ble Mr. H. R. Irwin, in the Chair.

The President welcomed Mr. Tunstall to the meeting and Mr. Tunstall addressed the Meeting as follows :—

MR. CHAIRMAN, GENTLEMEN.

During my last visit to Darjeeling I lectured on one of the methods of dealing with fungus blights—spraying. This year I propose to deal with the subject from a larger standpoint embracing all the methods of blight treatment. You will remember that in my last lecture I pointed out that in a district like this, where gardens adjoin, to carry out the treatment of fungus blights economically it was necessary to co-operate. I am still of that opinion and I now wish to put forward a definite scheme in the hope that you will criticise it and improve it to suit special conditions which I may have overlooked.

Before doing this it would be well for us to consider briefly the nature of the enemy we are designing to combat.

WHAT A FUNGUS IS.

A fungus is a plant of a lower order than the flowering plants, ferns and mosses, which are commonly known as plants. Some of the simplest fungi are merely lumps of jelly which roll over and engulf their food and which when fully matured split up into myriads of fragments each of which is capable under favourable circumstances of becoming a new plant. Other fungi are more complex and instead of an almost structureless lump of jelly have a body (or mycelium) made up of fine threads called hyphae. These are in the most highly evolved forms arranged in a characteristic structure as for instance the mushroom or the bracket fungus.

How fungi are propagated.

The simplest manner in which fungi are propagated is by simple division of the mycelium. The fungus body increases in size, and fragments may become detached to form new individuals or it may split up into fragments, rounded off and protected in various ways, which are called spores. The latter method may be preceded by a sexual process so that the spore thus produced may be said to correspond to the seed of a flowering plant. A flowering plant however produces only one kind of seed while a fungus may produce half a dozen different kinds of spores each of which is specially adapted to a particular set of conditions. Some of these spores are only able to survive a few days and are produced at a time when the weather and other conditions are specially favourable to their obtaining a suitable resting place. Others are specially designed to stand long periods of adverse conditions. Some of the latter have a period of rest during which they cannot be induced to germinate however suitable the conditions. This arrangement enables many fungi to survive the winter. If it were not for this resting period the spores would perhaps germinate during a temporary spell of favourable weather and then perish during a subsequent return of unfavourable conditions. The resting period prevents their germination until the spring. Some parasitic fungi spend a part of their life history on one plant and the remainder on an entirely different species. The spores produced and the general habit of the fungus may be so different under the two sets of conditions as to suggest that the two stages belonged to separate fungi.

The liberation of fungus spores.

There are many arrangements by which nature ensures that the spores be properly launched. As an illustration of one of these devices the liberation of the spores of a mushroom may be cited. The spore-bearing surfaces of a mushroom are arranged on vertical gills under a protecting cap. If a spore were merely detached its escape would be impeded by friction against the gills, it is therefore shot off with just sufficient force to take it mid way between the two gills so that it falls clear into the open. Most fungi regulate

the liberation of their spores so that the majority are set free in favourable weather. For instance in some of the mushroom fungi the gills are split at their free edges and in dry weather unfavourable to the development of fungus spores the edges curl over and so prevent them escaping. A simple experiment will show that the blister blight fungus also regulates the liberation of its spores. If a piece of black or dark coloured paper be fixed under an active blister the discharged spores may be seen as a white powder on the paper. On a dry day there will be fewer spores liberated than on a dull wet one.

Methods of distribution of fungus spores.

Fungus spores are very small, some of course are larger than others ; but they are all hundreds of times smaller that the smallest seed. Some spores are provided with sticky coats which cause them to adhere to insects and other animals with which they are brought into contact. The spores of *Gleosporium*, the cause of dieback, and *Colletotrichum*, the cause of brown blight, are so provided and there is no doubt that animals such as green fly and red spider are important agents in their distribution. Most fungus spores are capable of being carried about by human beings. The coolies employed in the cultivation of the tea must be important agents in the distribution of fungus spores. They brush them off one bush on to another. A gang of women may pluck a piece of tea infected by blister blight to-day and to-morrow, using the same baskets and the same clothes, would be plucking another uninfected section. The spores of the disease are brushed off on to the uninfected bushes and very soon they are infected too. I have noticed that new infections often start alongside foot paths leading from infected gardens. Men and animals are however not nearly such important agents in the distribution of fungus spores as air currents. In consequence of their small size, their superficial area is very large in proportion to their weight so that the friction of the air retards their falling to a very considerable degree. When the surfaces of spores are further increased by roughenings and hairy protruberances it is easily understood that they may be carried very far by the wind before they find a

resting place. Grey blight has special floating attachments which correspond to the down of a thistle. If the spores are able to survive the exposed conditions, a disease may be carried by the wind many miles over open country at one time. In Darjeeling the contour of the land is very favourable to wind distribution and there is no doubt that the latter plays an important part in the distribution of blights such as blister blight. Besides the special devices for the protection and distribution of spores a fungus further safeguards itself from extinction by producing enormous numbers of spores. Not in thousands but in millions are they sent forth: On a single blistered leaf at least a 100,000,000 spores are produced.

There are two essentials to the successful distribution of a fungus disease.

1st. For the live spores to be distributed to fresh host plants.

2nd. For the host plants to be in a suitable condition for infection.

METHODS OF PREVENTING THE DISTRIBUTION OF FUNGUS SPORES.

In the plains the distribution of fungus spores from one garden to another is hindered by large belts of jungle often miles in width. There seems to be little doubt that these stretches of jungle act as filters to the wind and thus prevent distribution by that—the most usual method. The spread of a fungus which only attacks tea in districts where gardens are so separated almost invariably follows the roads.

Experiments recently conducted in America show that belts of trees have a remarkable filtering effects on air currents. Also recent research on various insect pests show that they are also very effective barriers to the distribution of certain insect pests, for instance the shot-hole borer. One of the most obvious methods of isolating pieces of tea from one another is by planting wind-breaks of suitable trees. In a district like this the contours of the land would possibly nullify the effect of windbreaks although I distinctly remember noticing the retarding effect of a belt of trees a few dozen yards broad on the spread of blister blight on one garden. The blight did not go over the belt but spread round it

inspite of the fact that the hillside was very steep. I do not suggest that a lot of money be spent on planting wind belts, but only that observations should be made as to the effect of existing wind belts on the distribution of blights. It may be found that a belt of reasonable width in certain positions would check the spread of a fungus disease or insect pest for a sufficiently long time to enable steps to be taken to eradicate the blight while it was still confined to one section. Wind-breaks may be effective on one garden and yet on another by reason of some peculiarity of contour they may be quite useless. It is impossible to generalise and I merely put forward the suggestion tentatively.

Distribution of fungus spores by coolies to be avoided.

That fungus spores may be carried about on the coolies clothes has been pointed out already and it is obviously foolish to allow coolies to proceed to uninfected areas immediately after working on infected areas. On the outbreak of disease special coolies should be told off to do all the operations necessary on the infected areas. These coolies should not be allowed to work on uninfected tea until the spores they have possibly picked up have had time to die. This in the case of blister blight would be about three days. By exercising a little common sense a good deal of unnecessary loss may be avoided.

Rendering the host plant immune by manurial applications.

In the other essential factor to the successful distribution of fungus disease—the receptive condition of the host plant, we find one of the best opportunities of dealing with blight attacks. Experiments have from time to time demonstrated that the susceptibility of plants to particular diseases may be influenced by manurial applications. From the observations made in this district however it was found that the quantities of manure required to bring about an appreciable reduction in the amount of blister blight were such as to render this method of treatment impracticable. There is still hope that in the light of later investigations this method may be made practicable.

SPRAYING.

So far I have only mentioned indirect methods of fungus blight control. Spraying is the most satisfactory direct method of blight treatment. A spray fluid not only renders the plant immune to blight by clothing it with a blight proof armour but also kills the fungus wherever it comes into contact with it. In addition some fluids have the still further advantage of stimulating the plants to which they are applied.

RECENT OBSERVATIONS ON SPRAYING.

The results of my recent observations on spraying in other districts may interest you. I will not detain you with details of actual experiments but will only mention results.

The two principal types of sprayers, the barrel fitted with long tubes and the knapsack, were tested against one another, and the knapsack type was proved to be far away the best. I should not advise anyone to purchase machines of the barrel or tank type. Of the knapsack types of machine I am still of the opinion that the pneumatic are the best. Of these the battery kind are the most satisfactory. The following are some points in favour of the latter :—

1. The machines which are placed in the hands of the cooly have very few working parts. In the best kinds the only parts that work are a ball valve and a simple tap. The rest of the machine is merely an airtight cylinder of non-corrosible metal.
2. The charging is automatic, straining is done properly and no solution can be spilled.
3. The size of the cylinder of the pump render charging an easy and rapid operation and there is no time lost in pumping up the machines out in the tea as they are properly charged at the commencement of the operation.
4. The charge pump is large and the wearing parts in proportion so that it is likely to have a longer life

and be less liable to get out of order than a smaller pump.

5. The pump (which contains all the parts of the plant likely to go wrong) may be placed in charge of a competent mistri who besides superintending the work could execute minor repairs such as tying on rubber tubes, cleaning clogged nozzles, etc.

There are a few improvements still necessary.

1. The common type of battery charge pump is fitted with a lever action. This is not so satisfactory as a wheel and eccentric. The coolies rarely use a lever pump properly. The strokes are always jerky and too short. This could not occur in a wheel and eccentric action.
2. The nozzles fitted to most machines are unsuitable as they produce their spray too far from the aperture, the result being that in closely planted tea the spray cannot form properly as the nozzle cannot be held far enough away from the bush.
3. The single nozzle arrangement which is usually supplied is inadequate. The coolie has to spend too much time over each bush. An arrangement which allows the operator to spray both sides of gully while walking straight ahead is required. It may not be possible to spray the bushes so thoroughly by this arrangement, but, in spite of that, the spraying would in all probability be done more satisfactorily as there would be a smaller strain on the coolies good will and intelligence. It is, I think, better to spray the whole estate fairly well than to spray one small piece thoroughly.

Of spray fluids I have little to say except that I have realised that it is useless to advise the use of fluids which require any special care in their preparation, *e.g.*, "Woburn Winter Wash." This solution has been most effective where properly made but in other cases it has been found to cause considerable damage. It is, I

believe, in many cases impossible for the management to give the necessary amount of supervision to the manufacture of spray fluids, and it is frequently more satisfactory even if more expensive to use ready-made preparations of known value.

A CO-OPERATIVE SCHEME NECESSARY.

I think I am right in saying that the treatment of blights is now being attempted on most of the gardens in this district, and most planters recognise its necessity, but you realise from the foregoing remarks on the distribution of fungi that if a disease like blister is to be stamped out or even kept in control something more besides individual effort is required. The great war has taught us the wonderful results which can be brought about by skilful organisation. Blister blight alone is an enemy which is costing you many thousands of pounds every year, yet this disease has so far only been attacked in a haphazard way. Organisation and co-operation and subordination of pretty personal inclinations, are as essential to the successful treatment of fungus enemies as they are to the defeat of the Germans. The arrangement of such a scheme is more a matter of business than of scientific investigation and I have hesitated to put one forward on that account. I am taking the liberty of doing so now however in the hope that you will criticise it, improve it until it seems quite satisfactory, and then *carry it out.*

A BLIGHT BRIGADE WANTED.

I think most difficulties would be overcome, if a permanent spraying brigade fully equipped with material and machinery be established. The brigade should consist of companies each of a competent mistri assisted by a number of sirdars. Whenever an outbreak of blight is reported a company with full equipment proceeds at once to the place. The mistri in charge arranges all details such as leading on water and the manufacture of solutions: the actual spraying being carried out by gangs of garden coolies each under the charge of one of the sirdars mentioned above. Whenever spraying operations are not being carried out, the brigade staff would be occupied in systematically searching for the blight;

each sirdar being allotted 400 or 500 acres. I think it would probably be advisable to have a separate company to each valley under the control of the valley. In case of an epidemic in any one valley being too severe for a single company to cope with, the help of other companies might be requisitioned.

To make my meaning clear I will take as an example one Valley—the Teesta Valley.

The following gardens are situated :—

Darjeeling Tea and Cinchona Gardens	...	1,000 acres.
Gielle	...	500 ,,
Rungli Rungliot ...	...	350 ,,
Teesta	...	750 ,,
	Total	2,600 acres.

(The figures may not be quite accurate but they will serve the purpose).

THE CAPITAL EXPENDITURE.

Sufficient machinery would be required for it to be possible to spray the whole area if necessary within a reasonably short time (say two months). It may be reckoned that allowing for bad weather, etc., one knapsack machine can spray 20 acres per month. That means that to spray 2,600 acres in two months requires $\frac{2,600}{20 \times 2}$ *i.e.*, 65 machines. First class machines should not cost more than Rupees 50 each including freight and packing.

Hence the outlay for machines would be about	Rs. 3,250
In addition to the actual machines the following articles are necessary. Scales, Weights, measuring vessels, barrels, tanks and repairing tools.	
These would not exceed .. ... ,,	1,000
A stock of chemicals would be necessary say ... ,,	2,000
A good godown for the storage of the machines and chemicals is also necessary. This would not cost more than ... ... ,,	250
Houses for the staff, and other contingencies say... ,,	300
Making a total of Rs.	7,000

The annual expenditure.

First of all it is extremely important to obtain a really good man to take charge. He must be sufficiently intelligent to understand fully the reasons for his work and must be a good enough mistri to superintend the repair of the machinery. In addition to the actual spraying he would have to superintend systematic searching operations for the blight throughout the year and also keep full records and accounts.

A mere clerk is not the sort of man required. An intelligent mistri who could write English would be suitable. It would probably be necessary to pay more for such a man than for a clerk and I allow a salary of rupees 50 per month. An annual expenditure of Rs. 600.

Assistants would also be needed. On a total area of 2,600 acres six would suffice. These would be intelligent coolies and their business would be to prepare all the spray fluids, clean the machines and generally act as sirdars of spraying gangs. When there were no spraying operations going on they would have to search the tea for the blight, each man having special areas allotted to him. I would suggest ten rupees per month for those men

making an annual expenditure	Rs.	720
Allowing 15% for depreciation on machinery, etc.	,,	750
and for emergencies another	,,	200
a total annual expenditure is incurred of ...	Rs.	2,270

Hence the brigade account would be as follows :—

Capital expenditure	Rs.	7,000
Annual expenditure	,,	2,270
Total	Rs.	9,270

The scheme an insurance against blight.

A difficulty in arranging a scheme of this nature lies in the fact that all gardens are not equally damaged by blights, and, the proprietors of such gardens naturally object to pay a lot of money for the benefit of their less fortunate neighbours. I think this

difficulty would be overcome by charging a fee per acre treated and making the fee sufficiently large not only to cover actual expenditure, but also to leave a balance to provide a small interest on capital expenditure. Hence a garden free from blights would only have to put down the capital expenditure, and would receive a small interest on that. Although the interest in all probability would be less than that which may be expected from a good investment the loss may be counted as insurance against blight. You insure against hail, you insure against fire, then why not against blight? You may have hail, you may possibly get fire, but you are certain to get blight.

The Brigade would deal with certain specified blights. The selection of these would be arranged by your Association. Our department would instruct the members of the brigade in the best methods of controlling them. By attacking the diseases when they were most vulnerable the work would be very considerably reduced. For instance, in the case of blister blight, the disease would be searched for and treated in the cold weather, and, if every subsequent outbreak were reported and treated at once, there would never be any need for spraying large areas. The officers of the brigade would require careful training and their supervision would require care, but I feel confident that the difficulties likely to be met with would be overcome.

I feel sure you all see the grave necessity for doing something on these lines. Consider the helpless position of your district at the present time. Suppose a really serious disease broke out: a disease which killed out the bushes and spread with the rapidity of blister blight. In a few weeks the famous tea gardens of Darjeeling would have ceased to be. This is not a far fetched notion. Such a catastrophe happened not so many years ago in the coffee districts. Gentlemen, the position is unsound. The tea in the district is as open to destruction, without a co-operative scheme of blight treatment, as our Empire would be without the navy. A small initial expenditure and a negligible revenue expenditure would place a weapon in your hands with which a serious attack of blight or pest may at any rate be held in check. The success of such a scheme requires the active co-operation of every garden in the

district. There are so many different interests involved that the voluntary co-operation of the whole district cannot be expected, and, I suggest that if the majority of the planters in the district agree to it, the local Government be asked to make it compulsory. Many of you have had experience of other parts of the world and you know that in the Colonies and in America the Government concerned make stringent laws for the control of pests and blights. I do not foresee any grave objections to the adoption of such a course by our own Government in the case of the tea industry.

To-day we will only discuss the principle and, if you agree, the details of the scheme could be worked out by your Committee. If a scheme be agreed upon the sympathy of the other branches of the Tea Association may be solicited and a joint petition placed before the local Government.

NOTES.

Treatment of oilcake.—In Bulletin No. 63. Ag. Res. Inst. Pusa,* the following note occurs :—

> "This method is particularly successful when used for preparing a rapid acting nitrogenous organic manure from oilcake, the latter being mixed with one quarter of its weight of soil and a small proportion of bone dust (from 2-5 per cent.) or superphosphate, watered with extract of cowdung, made into a heap, saturated with water, then covered with soil, kept moist and allowed to ferment for 2-3 weeks. The resulting manure is an excellent one for turf or garden plants, and depends for its rapidity of action upon the semi-anaerobic decomposition set up in the heaps. It should be noted, however, that before use in the garden it must be exposed to the air for at least a week to oxidize the bacterio-toxins produced during fermentation; this is not necessary in the case of turf, but the rate of application must be regulated to allow of oxidation proceeding *pari passu* with incorporation into the soil."

The object of watering with the extract of cowdung is to introduce the bacteria which are capable of destroying cellulose.

Oilcake is at present the cheapest source of nitrogen available to a tea estate.

On light soils its use is practically always successful, but on heavy soils it is so slow in action as to be frequently without much effect.

The above note suggests a method of preparation which should render oilcake available for application to heavy soils.

Bone dust or other bone products are manures which are all the better for such preliminary treatment, and in the case of soils

* A modified method of Green-manuring, C. M. Hutchison.

which are in need of phosphates the proportion of bone dust might be increased with advantage.

A mixture of 7½ maunds oilcake with 2 maunds bone dust treated in the way described would provide a good rich all round manure and would be sufficient to provide a good dressing for one acre at a cost for materials of about Rs. 20, and would almost certainly be found more effective than any mixture of more readily available and more expensive manures providing the same quantities of nitrogen and phosphoric acid.

The effect of various dressings on pruning wounds of fruit trees*—" An account of experiments, begun in 1911, with different substances on pruning wounds of fruit trees, in order to determine the effect of the various compounds in accelerating the cure of the injury and their preservative action against the attacks of fungi and injurious insects. These experiments have been made on apple trees (as representative of the pome fruits) and on peaches (as representative of stone fruits.) The following substances were employed: white lead, white zinc (both mixed with linseed oil,) yellow ochre, coal tar, shellac, and avenarius carbolineum. They were applied, at different times of the year, to pruning wounds of various sizes, some newly inflicted and others of some weeks' standing. The effects were observed, both in the case of the treated wounds and in that of those which were left open, at the end of the first and the second season of growth.

The principal results were as follow :—

"In all cases the untreated wounds healed more rapidly than those protected by any of the substances enumerated. Amongst the latter, shellac seemed, during the first period of growth, to exercise a stimulating effect on the development of bark around the wound ; this effect, however ceased at the second period of growth. Shellac caused the least injury to the tissues of the cambium, but,

* Howe, G. H., in New York Agricultural Experiment Station, Bulletin No. 396, pp. 83-94 Geneva N. Y. February 1915.

Quoted from the Monthly Bulletin of Agricultural Intelligence and Plant Diseases.

on the other hand, it had the least adhesive power. Avenarius carbolineum and yellow ochre did so much harm to the cambium that, in the writer's opinion, they should never be used for covering pruning injuries. The lesion produced by coal tar was less serious, but this substance disappeared more quickly owing to absorption and evaporation—White lead and white zinc also produce a slight injury to the cambium tissues when they are first applied, but these tissues soon recover, and at the end of the first growth period hardly any trace of injury is left. White lead and white zinc were the most efficacious of all the compounds used, and the former was the better of the two.

"Nothing is gained by waiting some weeks after pruning before applying the dressings.

"All the substances used in the experiments in treating the pruning injuries of peach trees produced such damage to the wood, that the wounds did not close. Consequently these substances should never be applied to the wounds of the peach ; this probably applies to all other trees with stone fruit.

"In no case were the wounds, whether open or protected, observed to be invaded by fungi. As the substances used seemed rather to retard the healing of the wounds, it may be concluded that the treatment of injuries to the wood is, to say the least, useless. Nevertheless, had the experiments been carried further, it is possible that they might have exercised a useful effect upon the healing of very large injuries ; this, however, still remains to be proved."

It is to be noted that the results apply to wounds that were not invaded by fungi, but in the tea districts the climate is much more favourable to the growth of fungi and wounds are more liable to infection. In the case of healthy tea plants, however, clean wounds heal without any difficulty and it would seem that generally there is no need for the application of any special protecting coat.

Some experiments were made by Drs. Bernard and Deuss in Java recently on the subject which have been described shortly in a

report by the Chief Scientific Officer on certain aspects of the tea industry of Java and Sumatra. (Pamphlet No. 2 of 1916, Indian Tea Association.)

In the case of Sau trees and other soft wooded plants infection of wounds by fungi is the rule rather than the exception and some protection is necessary.

Rats on Coffee Estates.—De Raadt. (O. L. E.) Bijdrage tot de Kennis der Epidemiologie van de pest of Java (Contribution to the knowledge of the epidemiology of plague in Java) Meded. Burgerlijk. Geneesk. Dienst Ned-Indie, Batavia, 1915, pt. 4, 1916, pp. 20-38. 3 plates.*

The second section of this paper covers investigations concerning the biology of Javanese house and field-rats. There are two varities of the house-rat in Java, namely the larger, *Mus rattus griseiventer*, Bonh., and the smaller *Mus rattus concolor*, Blyth. Though morphologically distinct, these two varieties do not differ in their habits ; being climbing species, they both live by preference in the upper parts of houses and are therefore of great importance as regards human plague. In view of the fact that Java is very thickly populated, the villages being at comparatively short distances from each other, about three-quarters of a mile on an average, it was of interest to ascertain whether house-rats were really incapable of moving from one village to another. In certain experiments it was found that from 5 to 9·6 per cent. of the rats caught in the rice-fields, at an average distance of about 650 yards from the nearest village boundary, were house-rats ; the rest were all field-rats. From the X cheopis index on the former, they must be held to have emigrated from the houses and to be living in the fields temporarily. In July 1913 an outbreak of rats were reported in some coffee plantations, in the district of Malang, *Coffea robusta* being chiefly affected. According to Dr. Wurth, the fact that *Coffea liberia* (Liberian coffee) and *Coffea arabica* (Java coffee) have not such a strongly developed pith or so soft a bark, accounts for their comparative immunity. The author commenced an investigation as to the rats on the Kalli Tello and Alas Tledek

* Extracted from the Review of Applied Entomology Series B, August 1916.

plantations and found that there were from 36·7 per cent. house- and from 63·3 to 55 per cent. field-rats. Investigations made in Java-and *Robusta*-coffee plantations (where there had been no outbreak) showed 84·5 to 92·2 per cent. of house-rats. They were therefore not responsible for the outbreak, and form the chief portion of the normal rat population of the coffee-plantations. The smaller examples. *M. concolor*, were mainly represented and it is supposed that these were driven out of the houses by the larger *M. griseiventer*. Their food-stores always consisted of the young shoots of *Saccharum spontaneum*, L. (wild sugar-cane) and the fruit of *Phyllanthus emblica* L. which grows wild in the plantations. They do not therefore damage the coffee-trees.

In Java the field-rat is represented by *M. rattus diardii*, Jentink. It is normally present in the proportion of from 1·6 to 15 per cent. in coffee-plantations, but this rises to 55 to 63·3 per cent. in coffee-plantations where the crop has suffered considerable damage from a sudden influx of rats. It may therefore be assumed that the injury of coffee is caused by rats which migrate and that these are field-rats. No definite reasons can be assigned for their attacking coffee which is untouched by normal rat population, but it may be supposed that the latter find the food they prefer more easily than those migrants suddenly placed in strange surroundings.

The price of manures.—In the following table are given the unit prices* of nitrogen, phosphoric acid, and potash for the various forms in which these manurial substances are offered at present in Calcutta. The prices vary with the state of the market. It must not of course be supposed that the manure which stands at the lowest rate per unit is necessarily the manure which offers the best value for money. Most of the manures are such that they must undergo decomposition in the soil before they are of use to the plant. In this decomposition they may suffer loss. This loss is usually confined to Nitrogen, which, however, is the most valuable ingredient. The disadvantages of soluble manures—the likelihood of their being lost by being washed out of the soil—may be avoided by giving a little at a time.

* As in December, 1916. In some cases they have increased considerably since.

Again some of the manures are relatively slow in coming into action. On our rain-washed soils this is often an advantage yet some of the manures decompose so slowly that a concentration of plant food in the soil sufficient to benefit the tea may not be reached. For many soils the real value of a manure is proportional to the quickness of its conversion in the soil into compounds which can be directly taken up by the plant. For example many of the naturally occurring forms of rock phosphate, though containing a large percentage of phosphoric acid are of little value as manure.

In the case of basic slag, bones, and other forms of manure not soluble in water, a fine state of division greatly increases their rate of decomposition in the soil. With such manures a guarantee of fineness of grinding should always be insisted on, and it is worth while to pay a slightly higher price for the more finely ground of such manures.

In preparing the tables given below the price per unit of the particular constituent for which the manure is mainly used is calculated. For the purpose of making these calculations a value for the other constituent or constituents which a mixed manure contains has to be fixed upon arbitrarily, in accordance with the value of the nitrogen, phosphoric acid, or potash in the form in which it occurs in the mixed manure. In the case of bone products we have fixed upon the value of the nitrogen as Rs. 10 per unit, because Rs. 10 is the lowest unit value of nitrogen in any other form. We have no exact experiments on this point at present but it appears that the value of the nitrogen in bones is probably even less than this. If a smaller value for nitrogen were fixed upon the unit price for phosphoric acid would work out higher than the figures quoted in the table, but it should be noted that even if the nitrogen in bones is considered as valueless, the unit price of phosphoric acid is still cheaper than in any other form of phosphoric acid known to be of value.

In the case of nitrate of potash the nitrogen is in a form such that the plant can use it at once. The only other manures containing nitrogen in this form (nitrate of soda and nitrate of lime) stand at excessive prices, which are much greater than their real worth.

In nitrate of potash we have fixed upon Rs. 15 as a fair value per unit of nitrogen in accordance with the prices charged for other forms of readily available nitrogen.

Potash is very often of value for the purpose of growing a green crop. Where nitrate of potash is so applied the action of the immediately available nitrogen in giving a good start, certainly increases the value of the manure.

In the case of nitrogenous manures the best value for money at the present is found in the cases of oilcakes, and dried blood. Both these manures are useful. Oilcake always does well on light soils, but is often comparatively ineffective on heavier soils, particularly those which are not well drained or are for any reason in a state of poor tilth.

In such cases dried blood is usually found very much more effective, though in some such cases the still more readily available but expensive manures have to be used.

Organic manures such as oilcake, dried blood, animal meal, and fish manures are always more effective on soils which have been recently limed.

NOTE.—The letters a, b, c and d denote different suppliers.

MANURES.	Percentage Composition.			Price per ton.	Unit price.			Remarks.
	N.	P_2O_5	K_2O		N.	P_2O_5	K_2O	
				Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.	
Nitrogenous Manures—								
Nitrate of soda ...	(a) 15/16 (b) 15/16 (c) 15/16	... ...	... ...	(a) 280 0 0 (b) 260 0 0 (c) 280 0 0	(a) 18 11 4 (b) 16 12 4 (c) 18 11 4	... ...	... ...	
Sulphate of ammonia	(a) 20/21 (b) 20/21	... ...	... ...	(a) 315 0 0 (b) 295 0 0	(a) 15 2 0 (b) 14 6 3	... ...	... ...	
Nitrate of lime ...	(b) 15/16	...	...	(b) 260 0 0	(b) 16 12 4	...	...	
Nitrolim... ...	(a) 18	...	...	(a) 315 0 0	(a) 17 8 0	...	...	
Calcium cyanamide ...	(a) 18	...	...	(a) 315 0 0	(a) 17 3 6	...	...	
Nitros	(a) 14	...	...	(a) 220 0 0	(a) 15 11 5	...	...	
Nitro-ammonia ...	(b) 18	...	...	(b) 300 0 0	(b) 16 10 8	...	...	
Dried blood ...	(a) 12 (b) 10	... ...	... ...	(a) 145 0 0 (b) 120 0 0	(a) 12 1 4 (b) 12 0 0	... ...	... ...	
Rape cake ...	(b) 4/5	...	...	52 8 0	11 10 8	...	...	
Castor cake ...	(b) 5/6	...	...	77 0 0	14 0 0	...	...	
Ground-nut cake ...	(b) 7/8	...	...	94 8 0	12 5 4	...	...	
I. O. P. oilcake ...	(c) 4½	...	...	49 0 0	10 14 3	...	...	

NOTE.—*The letters a, b, c and d denote different suppliers*—(continued.)

MANURES.	Percentage composition.			Price per ton.	Unit price.			Remarks.
	N.	P_2O_5	K_2O		N.	P_2O_5	K_2O	
NITROGENOUS MANURES—(*continued.*) I. O. P. oilcake ...	(c) 5	...	...	Rs. As. P. 52 8 0	Rs. As. P. 10 8 0	Rs. As. P. ..	Rs As. P. ...	
I. O. P. oilcake ...	(c) 5½	...	...	56 0 0	10 2 11	...	...	
POTASH MANURES— Sulphate of potash ...	(a) (b)	...	25	200 0 0	...	...	8 0 0	Allowing Rs. 15 per unit of nitrogen.
Nitrate of potash ...	(a) 10 (b) 10 (c) 10	... ...	(a) 30/35 (b) 33 (c) 33/35	(a) 255 0 0 (b) 255 0 0 (c) 265 0 0	... ...	... ...	3 3 8 3 3 0 3 10 0	
PHOSPHATIC MANURES— Basic slag ...	(a) (b)	13/14 10/12	... ...	(a) 90 0 0 (b) 87 8 0	... ...	(a) 6 10 8 (b) 7 15 3	... ...	
Superphosphate ...	(a) ... (b) ...	20/22 20/22	... ...	(a) 100 0 0 (b) 90 0 0	... ...	(a) 4 12 2 (b) 4 4 7	... ...	
Ephos basic phosphate	(c) ...	27	...	(c) 120 0 0	...	(c) 4 7 1	...	
Indophos ...	(c) ...	18	...	(c) 80 0 0	...	4 7 1	...	
Basic phosphate ...	(a) ...	13/4	...	(a) 95 0 0	...	6 8 9	...	
Phosphate of lime ...	(b) ...	11/12	...	(b) 100 0 0	...	4 5 7	...	
Flour phosphate ...	(a) ...	30/35	...	(a) 95 0 0	...	2 14 9	...	

Note.—The letters a, b, c and d denote different suppliers—(continued.)

Manures.	Percentage composition.			Price per ton.	Unit price.			Remarks.
	N.	P_2O_5	K_2O		N.	P_2O_5	K_2O	
				Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.	
Bone Manures— Steamed bone meal ...	(*a*) 3½	22/23	...	75 0 0	...	1 11 1	...	Allowing Rs. 10 per unit of nitrogen.
Steamed bone meal ...	(*b*) 3½	22	...	80 0 0	...	2 0 8	...	
Steamed bone meal ...	(*c*) 4	22/23	...	72 0 0	...	1 6 9	...	
Steamed bone meal ...	(*d*) 4	22/23	...	80 0 0	...	1 11 1	...	
Unsteamed bone meal	(*a*) 3½	22/23	...	70 0 0	...	1 8 11	...	
Unsteamed bone meel	(*c*) 4	22/23	...	67 0 0	...	1 3 3	...	
Unsteamed bone meal	(*d*) 4	22/23	...	75 0 0	...	1 8 11	...	
Bone dust ...	(*b*) 3	22	...	70 0 0	...	1 13 1	...	
Bone dust ...	(*c*) 3	18	...	62 0 0	...	1 12 4	...	
Bone dust ...	(*d*) 3	18	...	70 0 0	...	2 7 1	...	
Guanos— Raw Peruvian guano...	12	30	2	310 0 0	...	5 5 1	...	Allowing Rs. 12 per unit of nitrogen.
Dissolved Peruvian guano No. (1) ...	5	25	2	240 0 0	...	6 15 1	...	
Dissolved Peruvian guano No. (2) ...	4	25	2	210 0 0	...	6 3 7	...	

NOTE.—*The letters a, b, c and d denote different suppliers*—(concluded.)

MANURES.		Percentage composition. N.	Percentage composition. P_2O_5	Percentage composition. K_2O	Price per ton.	Unit price. N.	Unit price. P_2O_5	Unit price. K_2O	Remarks.
					Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.	
MEAT AND FISH MANURES—									
Sterilized animal meal (ordinary) ...	(a)	7/8	7/8	½	132 8 0	15 8 3	...	...	
	(b)	7/8	7/8	½	135 0 0	15 13 7	...	...	
Sterilized animal meal (special) ...	(a)	7/8	7/8	2½	137 8 0	15 4 3	...	...	Allowing Rs. 2 per unit of phosphoric acid, and Rs. 3-3-0 per unit of potash.
	(b)	7/8	7/8	2½	140 0 0	15 7 7	...	...	
Sterilized animal meal (acme) ...	(a)	8½	5	5	158 0 0	15 6 8	...	...	
	(b)	8½	5	5	160 0 0	15 12 0	...	...	
Milled fish ...	(a)	5/7	5/7	...	130 0 0	19 10 8	...	...	
Sardine guano ...	(b)	5/7	10/12	...	125 0 0	17 5 4	...	...	
Fish guano ...	(a)	7/8	9/10	...	160 0 0	18 12 9	...	...	
Milled fish guano ...	(b)	7	9	...	165 0 0	21 0 0	...	...	
Nervox	(a)	10	4	...	125 0 0	11 11 2	...	...	
Ligox	(c)	10	4	...	70 0 0	7 3 2	...	...	

INDEX

TO THE

ISSUES OF 1916

OF THE

QUARTERLY JOURNAL.

A.

B.

B—(*concluded.*)

C.

D.

D—(*continued.*) PAGE

E.

F.

F—(*continued.*)

G.

H.

L.

M.

N.

O.

P.

R—(*continued.*) PAGE

S.

W.

X.

Z.

C.O. P.—1,100—13-2-1917.

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